Sua Pan Surface Bidirectional Reflectance: A Validation Experiment of the Multi-angle Imaging SpectroRadiometer (MISR) During SAFARI 2000

Wedad A. Abdou, Mark C. Helmlinger, David J. Diner, Jim E. Conel, Stuart H. Pilorz, John V. Martonchik, and Ralph A. Kahn

Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California

Charles Gatebe and Michael King

NASA/GSFC, Greenbelt, MD 20771

This paper describes the results of a comparison between MISR and ground field measurements of surface bidirectional reflectance, in attempt to validate MISR surface products. The data used in this comparison is from the Safari, 2000 campaign. In this campaign, simultaneous ground field and airborne measurements were collected, at several sites in south Africa during the Terra overpass time. The ground and airborne observations of interest here are those collected by the JPL team using sun radiometers, the ASD and the PARABOLA for ground measurements, and AirMISR for airborne measurements. Unfortunately, during the Safari campaign, the JPL ground field, AirMISR and MISR data were never collected simultaneously. JPL field measurements and MISR observations are simultaneously available only at Sua Pan, Botswana, on several days of the campaign. However, AirMISR did not fly over that site. Aeronet ground field measurements were available simultaneously with AirMISR and MISR observations at some of the sites, but PARABOLA was not available at those Aeronet sites.

Without AirMISR observations, a comparison of surface BRF and HDRF as retrieved from MISR data to those determined from PARABOLA does not provide a precise quantitative analysis due to the large difference between the spacial scales of the two observations. However, since Sua Pan surface is relatively homogeneous near the ground field location, such comparison may be qualitatively meaningful.

The ground field measurements used in this analysis are those collected by the PARABOLA at Sua Pan (Latitude -20.517o and Longitude 26.067o) on August 28 and September 3, 2000. Other data collected on the ground were the optical depth, measured by the Ragean_c sun radiometer, and the surface HDRF in the nadir, measured by the ASD instrument. MISR data for the above two days are obtained from orbits 3684 (path 172 and Block 107) and 3786 (path 173 and block 107) respectively. Both days were cloud free; however, on September 3, the aerosol loading was

much higher, as shown in figure 1. The ASD nadir measurements of the surface HDRF on those two days are illustrated in figure 2.

The PARABOLA data were processed to retrieve the surface BRF and HDRF at Sua Pan at a selected viewing and illuminating geometries. Figure 3 illustrates an example of the surface BRF at a sun angle of 35°. The BRF shows large backscattering characteristics. For comparison with MISR the results were interpolated at MISR observation geometries. Figures 4 and 5 illustrate the BRF and HDRF, at the camera angles, for August 27 and Sept. 3, respectively. As shown in these figures, the BRF and HDRF, as determined from either MISR or the PARABOLA, have almost the same values on August 28, where multiple scattering by the atmosphere is negligible. On September 3, there is a noticeable difference between the two parameters, especially in the forward scattering direction and at large view angles, where multiple scattering is most effective.

As shown in figures 4 and 5, the BRF and HDRF retrieved from MISR data, are generally lower than those determined from the ground measurements. This can be explained as due to the variability in the pan surface reflectance. MISR observations are averaged over a much larger area compared to that observed by the PARABOLA. The presence of darker surface areas surrounding the ground field location on the pan, most certainly contribute to lowering the averaged surface reflectance. Figure 6 and 7 are MISR images of Sua Pan on August 27 and September 3, respectively. Besides the haziness of the image on September 3, Sua Pan surface shows large variability in surface appearance from space. Figure 8 is a zoom image of the pan to show the ground field location. If AirMISR image was available, that location, which appears homogeneous over few of MISR pixels, may actually show some reflectance variability. The variability of the surface brightness was reported by Mark who, as he did at Lunar Lake campaign, on June 2000, surveyed a large area surrounding the PARABOLA position and made several measurements of the surface reflectance using the ASD instrument. Also, he collected PARABOLA measurements at different locations during the campaign from August 24 to September 3, in order to capture the variability of the pan surface brightness. The shaded areas in figures 9 and 10 represent the range of surface reflectance in the surveyed area. Though MISR data are not available to compare with all the ground field data, however, the average over all these data, as shown in figures 9 and 10 by the solid lines, is what MISR, actually, observed.

Another reason for the differences between MISR and PARABOLA results could be attributed to the Aerosol retrieval. Any error in retrieving the optical depth will be transported to the retrieval of the surface reflectance. The maximum disagreements shown in figures 4 and 5 are at the short wave channels and at the most oblique viewing angles, specially in the forward scattering direction, where aerosol multiple scattering is most effective. This is very clear in the data of September 3, where the aerosol optical depth in the blue was greater than 1.0. If the model retrieved is incorrect and underestimates the forward scattering, this will result in an overestimation of the forward scattering in surface reflectance, which is not observed on the ground. The best agreement is on August 27, in the NIR channel, where the optical depth was less than 0.1.

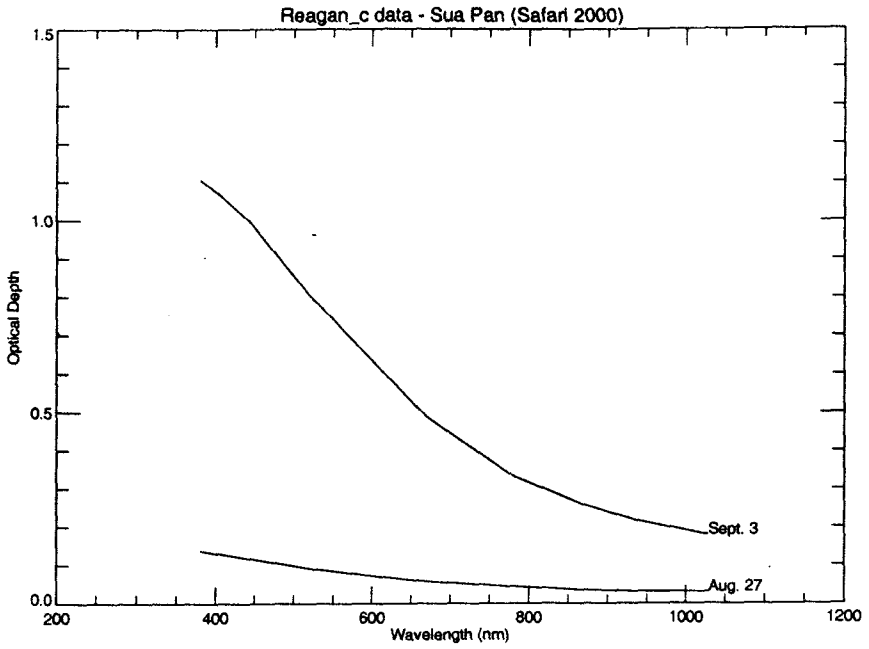

Figure 1.

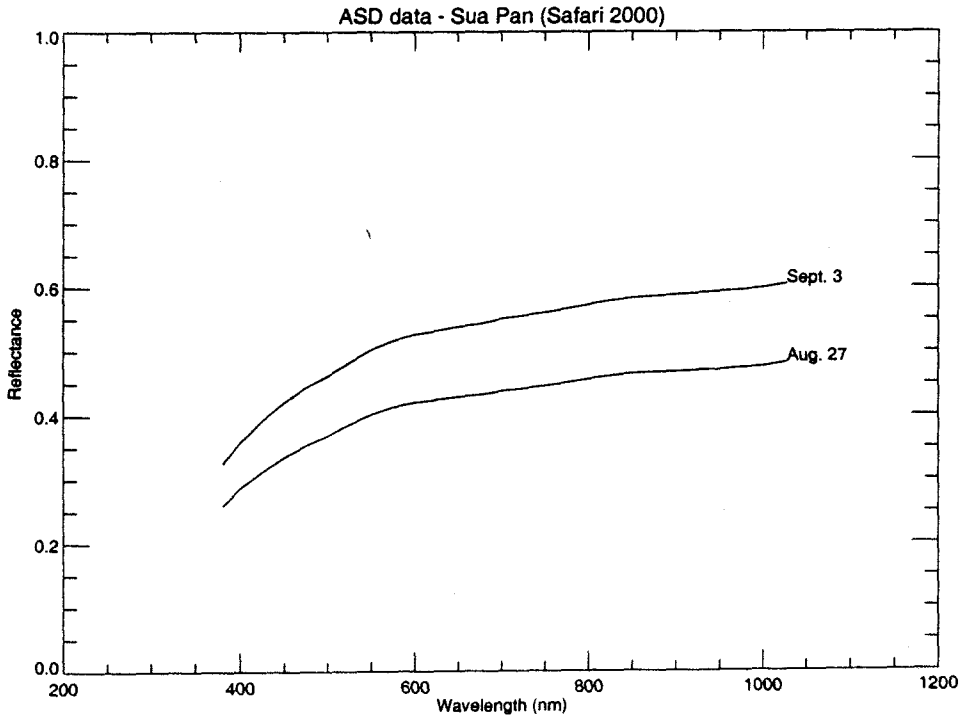

Figure 2.

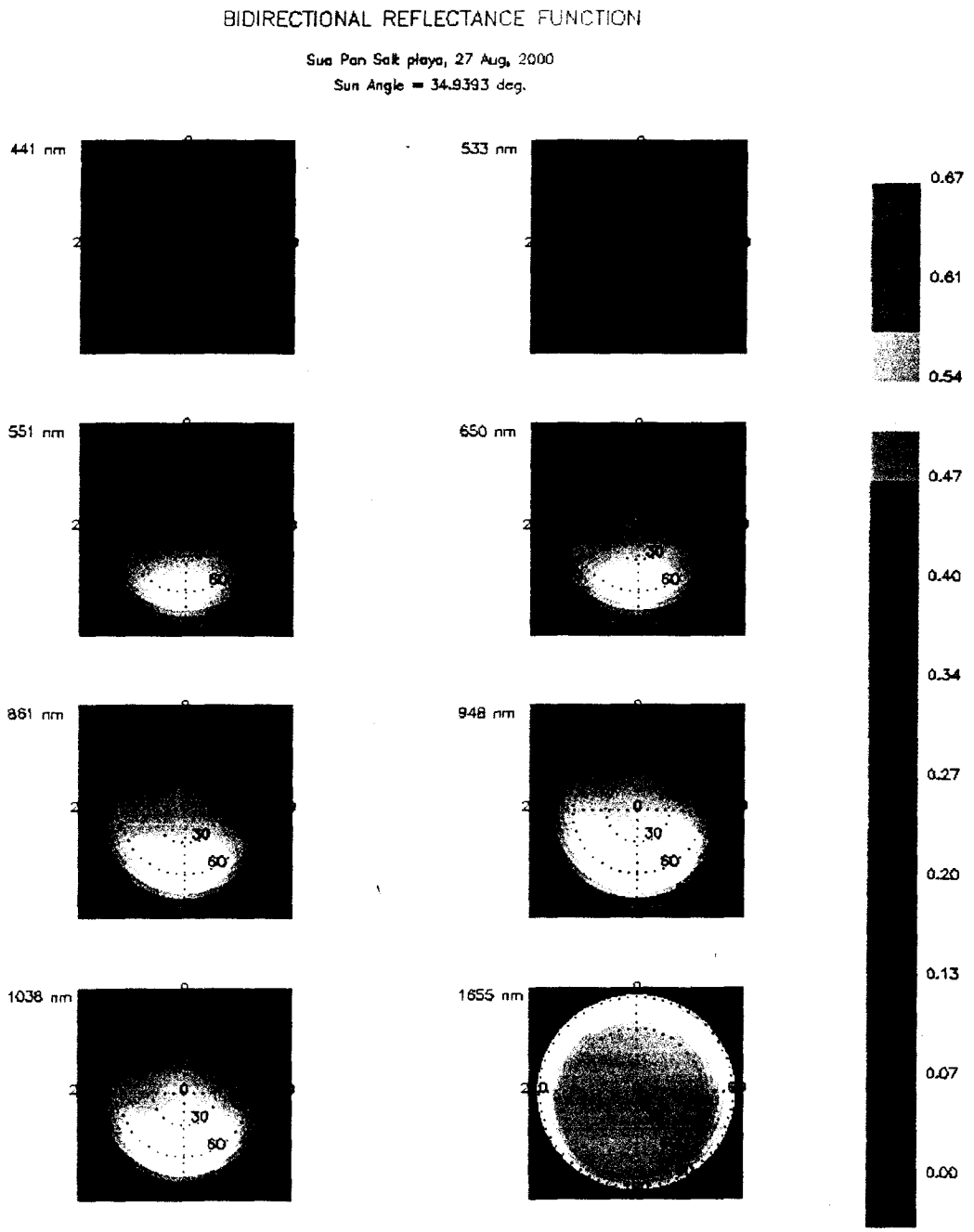
BIDIRECTIONAL REFLECTANCE FUNCTION
Sua Pan Salt playa, 27 Aug, 2000
Sun Angle = 34.9393 deg.
441 nm
533 nm
551 nm
650 nm
861 nm
948 nm
1038 nm
1655 nm
0.67
0.61
0.54
0.47
0.40
0.34
0.27
0.20
0.13
0.07
0.00

Figure 3.

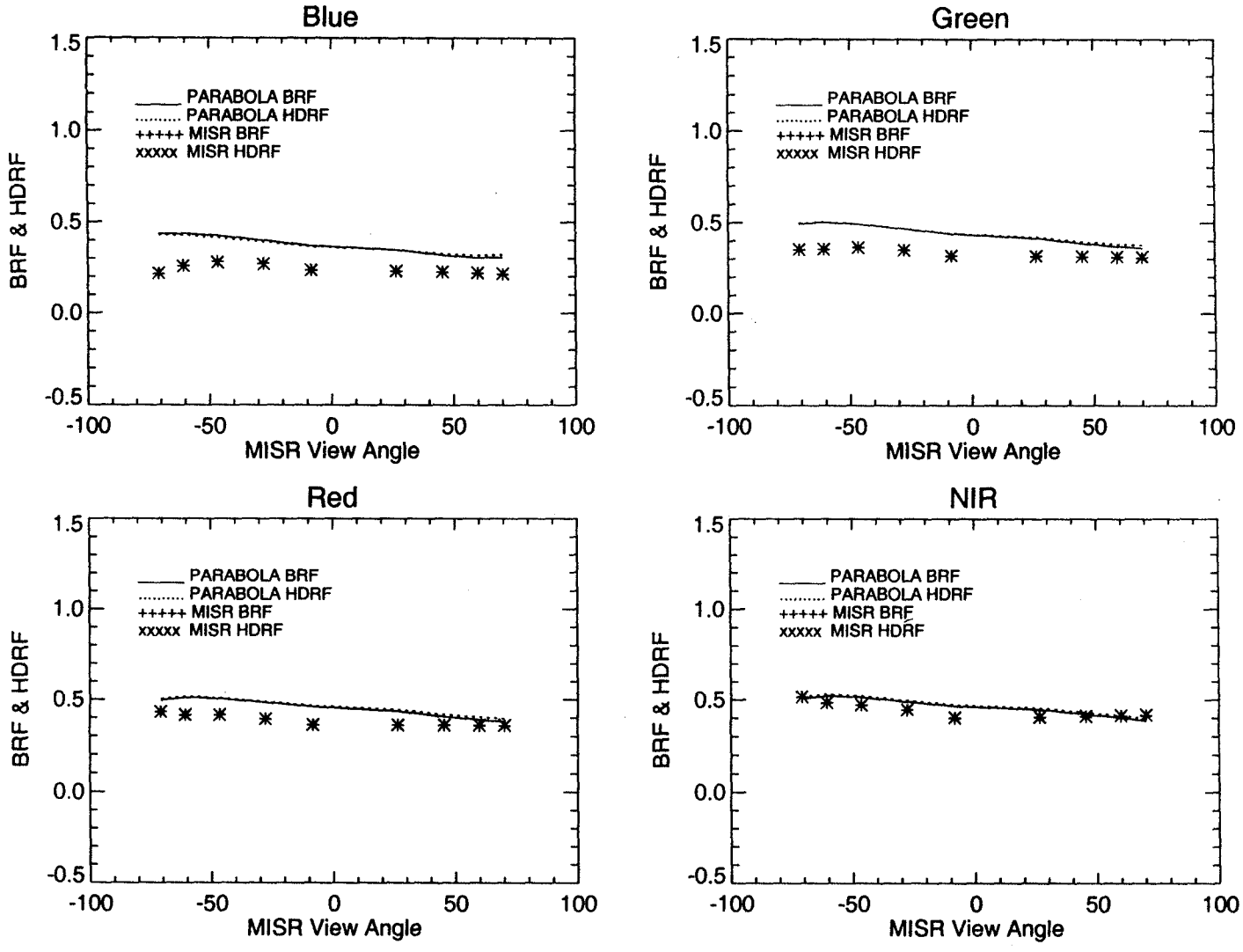
Sua Pan - Aug. 27, 2000
Comparison of field data with MISR retrievals
Blue
Green
Red
NIR
PARABOLA BRF
PARABOLA HDRF
+++++ MISR BRF
xxxxx MISR HDRF
BRF & HDRF
MISR View Angle
1.5
1.0
0.5
0.0
-0.5
-100
-50
0
50
100

Figure 4.

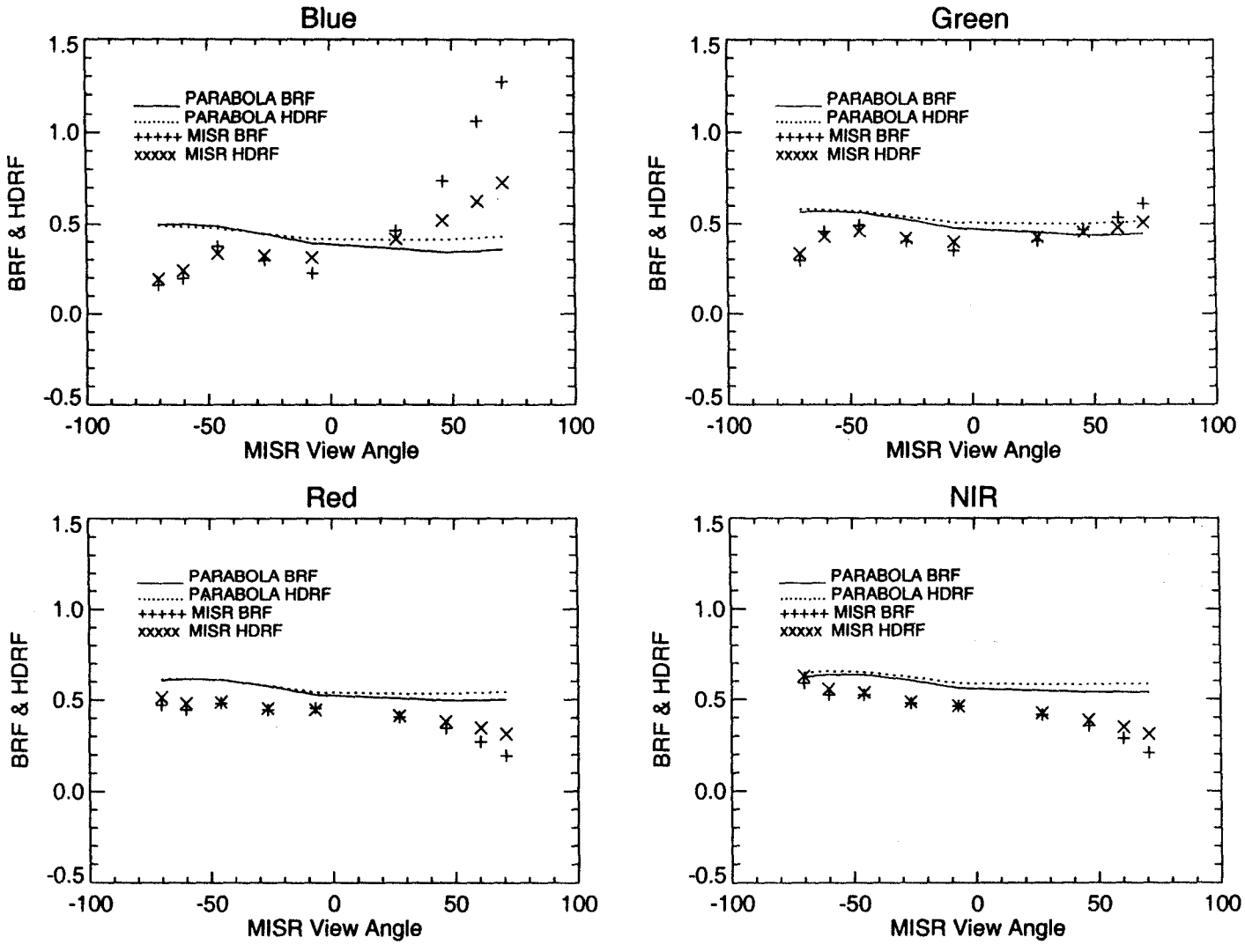
Sua Pan - Sep. 3, 2000
Comparison of field data with MISR retrievals
Blue
Green
Red
NIR
PARABOLA BRF
PARABOLA HDRF
+++++ MISR BRF
xxxxx MISR HDRF
BRF & HDRF
MISR View Angle
1.5
1.0
0.5
0.0
-0.5
-100
-50
0
50
100

Figure 5.

Figure 6.

Figure 7

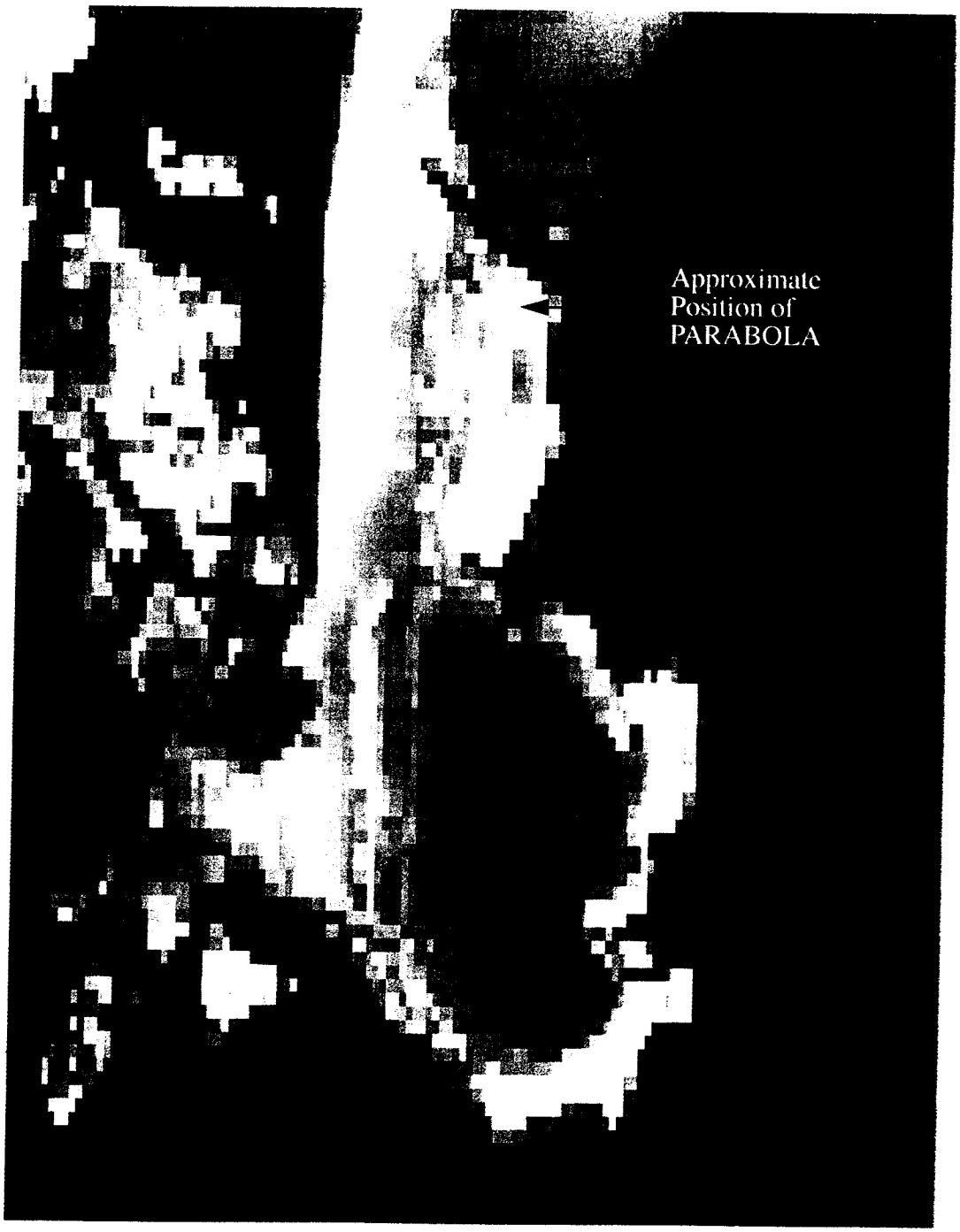

Figure 8.

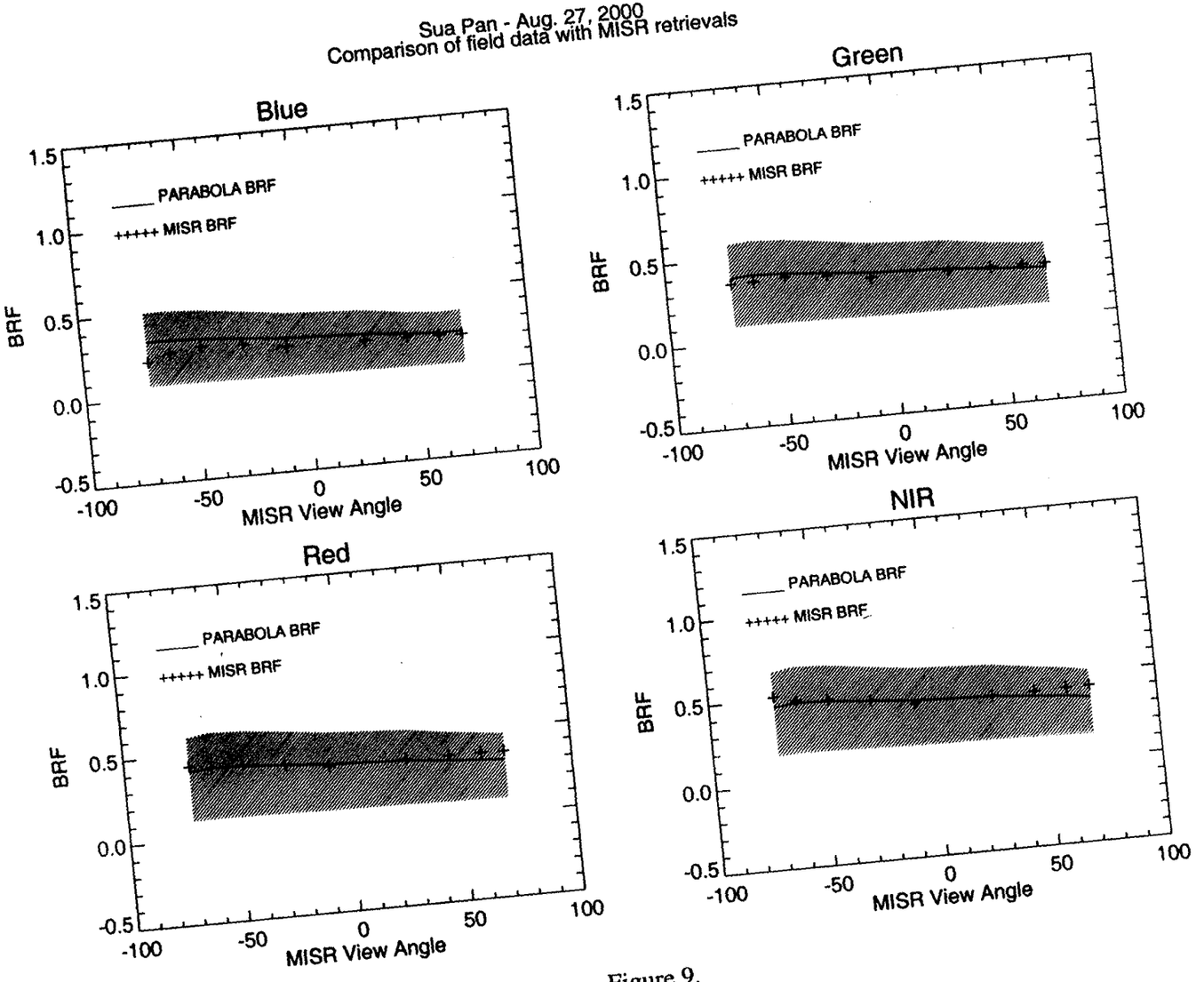
Sua Pan - Aug. 27, 2000
Comparison of field data with MISR retrievals
Blue
Green
Red
NIR
PARABOLA BRF
MISR BRF
BRF
MISR View Angle
1.5
1.0
0.5
0.0
-0.5
-100
-50
0
50
100

Figure 9.

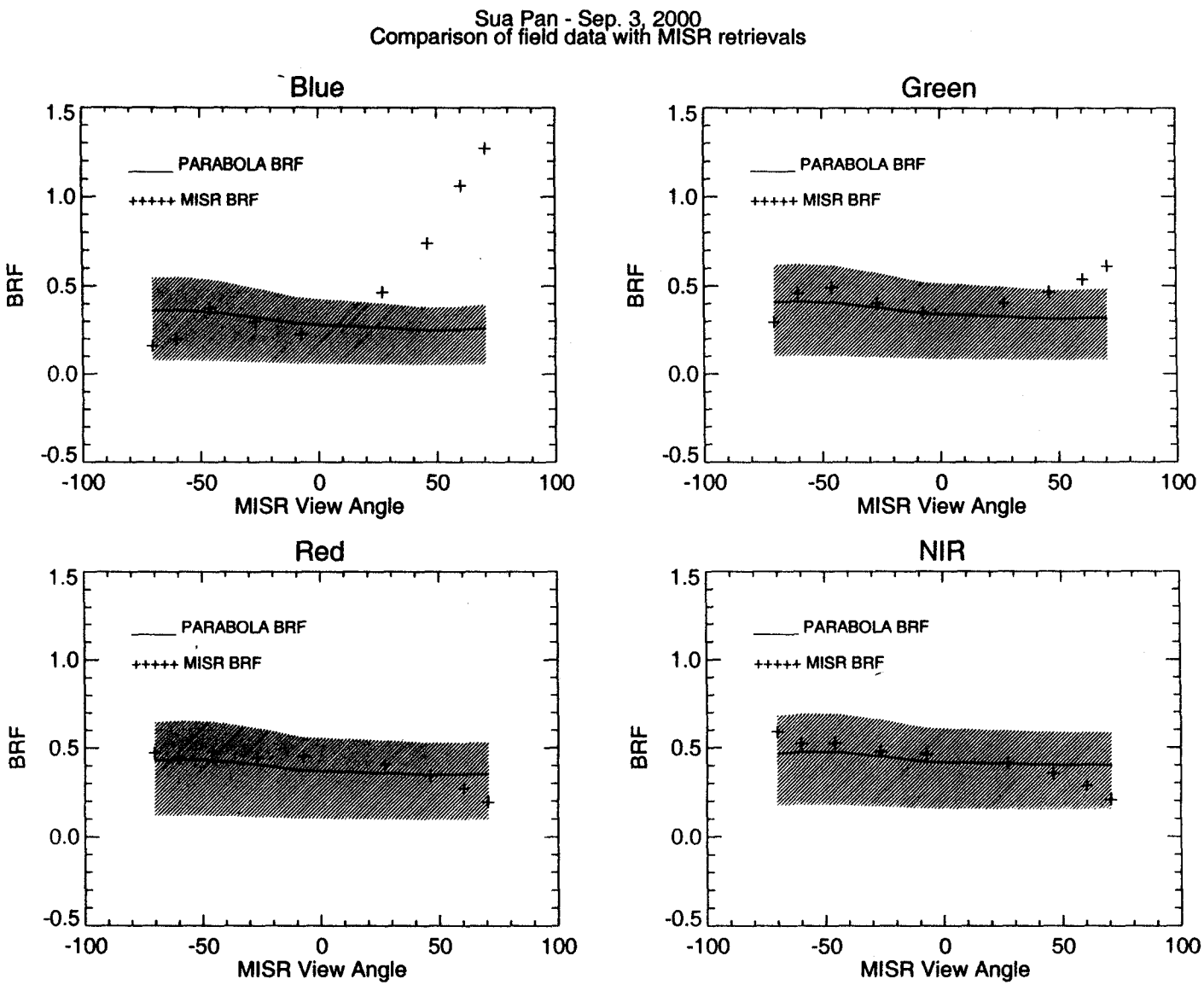
Sua Pan - Sep. 3, 2000
Comparison of field data with MISR retrievals
Blue
Green
Red
NIR
PARABOLA BRF
MISR BRF
BRF
MISR View Angle
1.5
1.0
0.5
0.0
-0.5
-100
-50
0
50
100

Figure 10.